Thus I conceive that multiplication should be defined from the outset in such a manner as would make it applicable to a fractional as well as to an integral multiplier. If I explain that to multiply 6 by 5 is to repeat 6 five times and find the aggregate result, my explanation fails when I am asked to multiply 6 by $\frac{3}{4}$; but if I use De Morgan's definition that "multiplication consists in doing with the multiplicand what is done with the unit to form the multiplier," or an explanation of multiplication cast in this form, I have given an explanation equally simple with the former and applicable also to a fractional multiplier.

Again, in the very beginning of arithmetic, which is counting, I maintain that much would be gained if from the first the child were taught to count, not one, two, &c., but *nought*, *nothing*, or *zero*, one, two, three, &c.; and then if, later on, ordinal reckoning were made to accord with this, though here unfortunately language and usage fails to supply the word wanted, for which, for want of a better, I must coin the form *zeroth* (*noughtth* or *nothingth* being out of the question), thus: *zeroth*, first, second, &c. Then the transition to counting below zero by negative numbers would follow at once as by a natural development, when the need for it arose. Thus when it came to the notation of numbers, the place of a digit would properly be reckoned from the units as the *zeroth* place (not the *first*), and would be extended naturally by negative ordinal reckoning downwards, when decimal fractions are introduced.

This leads me to another illustration, which I am also anxious to introduce as a suggestion on its own merits. Prof. Chrystal has complained that to many students even when beginning co-ordinate geometry the idea of the *order* of a term or an expression is unfamiliar. Now it has occurred to me that this is just the word wanted, to replace the five-syllable word "characteristic," which has been used (or perhaps has *not* been used just because it is pentasyllabic) to express the distance of any digit of a number in order from the unit's digit. Let us speak of the unit's digit as of the order 0; the tens, hundreds, &c., digits of the orders 1, 2, &c.; and the tenths, hundredths, &c., of the orders -1, -2, &c.; and add to this that a number is said to be of the same *order* as that of its highest significant digit, and we have a language not only of the utmost use and importance in decimal arithmetic, but also at once applicable by the most natural extension to an algebraical expression arranged according to the powers of some letter or letters, while it would enable us conveniently to express in language numbers which transcend our ordinary numerical vocabulary, so that, for instance, 53×10^{12} might be read as 53 of the 12th order, and 53×10^{-12} as 53 of the -12th order, and so on.

In conclusion I will only add that, if in this paper I have in any parts expressed myself somewhat dogmatically, I have done so in the hope of challenging discussion, and only claim the acceptance of the views which I have tried to express *distinctly*, if *briefly*, in the event of discussion resulting in a verdict in their favour.

ON THE METHOD OF STATING RESULTS OF WATER ANALYSES

THE Chemical Society of Washington is desirous of bringing before chemists and others interested, the report of Committee herewith inclosed; and as NATURE has a wide circulation in this country, I am authorised to send a copy of the abstract to your journal, hoping you may find space for it.

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Sec. Chem. Soc. Washington
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Washington, D.C., February 25

The Chemical Society of Washington, at the meeting of November 12, 1885, appointed a Committee to consider the present state of water analysis, and to present a method of stating analyses, adapted for general use, in order that those hereafter published may be readily compared with each other and with future work. This Committee reported February 11, 1886, and was authorised to prepare an abstract for publication, in order to call the attention of chemists to the subject. The Society earnestly recommends the adoption of the scheme which is herewith briefly presented. The full text of the report will be published in the next *Bulletin* of the Society.

(*Abstract*)

Water analyses are usually made to answer one of three questions, viz:—

(1) Is the water useful medicinally?
(2) Is it injurious to health? and
(3) Is it suitable for manufacturing purposes?

Many books relating to water were published during the eighteenth century, but accurate chemical analysis was not attempted until about 1820. As the earlier analyses were isolated, rare, and made for special purposes, the form of the statement was of little importance if it were only intelligible. At the present time, however, water-analyses are very numerous. An examination of about a thousand shows some forty two methods of stating quantitative results, there being sometimes three different ratios in the report of one analysis. Such discrepancies render comparisons difficult and laborious. The various methods of statement may be classified under the following general forms:—

(1) Grains per imperial gallon of 10 lbs. or 70,000 grains.
(2) Grains per U.S. or wine gallon of 58,372+ grains.
(3) Decimally, as parts per 100, 1000, 100,000, or 1,000,000.
(4) As so many grammes or milligrammes per litre.

The last two would be identical if all waters had the same density; but as the densities of sea water, mineral waters, &c., are much above that of pure water, it is plain that the third and fourth modes are not comparable. The Committee therefore unanimously recommends—

(1) That water-analyses be uniformly reported according to the decimal system, in parts per million or milligrames per kilogramme, with the temperature stated, and that Clark's scale of degrees of hardness and all other systems be abandoned.

(2) That all analyses be stated in terms of the radicals found.

(3) That the constituent radicals be arranged in the order of the usual electro chemical series, the positive radicals first.

(4) That the combination deemed most probable by the chemist should be stated in symbols, as well as by name.

The abandonment of Clark's *scale* has been recommended by Wanklyn and Chapman; and the recommendation made by the Committee does not involve the disuse of his method, but merely the bringing it into accord with the decimal system—the changing from grains per gallon to milligrammes per kilogramme.

The last conclusion (4) was deemed desirable from the frequent confusion in the statement of the iron salts and of the carbon oxides.

The Committee is unanimously of the opinion that analyses in the form recommended will prove quite as acceptable to Boards of Health and to the public in general, for whom such analyses are often made, as if presented in the mixed and irregular forms commonly adopted.

The Committee also feels sure that the people in general are better able to form a definite idea of the character of a water from a report stated in parts per 100, parts per 1,000,000, &c., than from one expressed as grains per gallon, the latter being a ratio wholly unfamiliar to any but those in the medical or pharmaceutical professions.

(Signed) A. C. PEALE, M.D.
WM. H. SEAMAN, M.D.
CHAS. H. WHITE, M.D.

ON SOME POINTS IN THE PHYLOGENY OF THE TUNICATA

IN his monograph on the genus *Doliolum*, forming one of the recent parts of the series illustrating the Fauna and Flora of the Bay of Naples,[1] Dr. B. Uljanin gives a sketch of the phylogeny of the Tunicata, some parts of which cannot, I think, be accepted without considerable modification. Uljanin has evidently regarded the subject from the *Doliolum* point of view, and, in fact, he only introduces the other groups of Tunicata for the purpose of discussing their relationships to *Doliolum*. Consequently it is not to be wondered at that he should assign rather too central a position to that genus, and give it too much importance relatively to the other groups. What is of more importance is that his scheme shows a course of evolution which seems not altogether in accordance with

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[1] "Fauna und Flora des Golfes von Neapel." X. Monographie: Doliolum, von Dr. Basilius Uljanin. (Leipzig, 1884.)

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what is known of the anatomy and embryology of the various forms.

In the first place the diagram given on page 123 shows the lines of development of certain groups passing through other existing groups, an arrangement which should be avoided in phylogenetic tables. It always suggests that the groups passed through are the direct ancestors of the group at the free end of the line, and it is highly improbable that any existing forms are precisely the same as the ancestors from which a group was derived. To take an example, Uljanin represents the line of evolution of *Doliolum denticulatum* passing through first *Anchinia rubra*, and then *D. mülleri*, thus suggesting, I hold, that the two last-named species are extinct forms which were direct ancestors of *D. denticulatum*. Now of course *A. rubra* and *D. mülleri* are not extinct, and although they are undoubtedly closely related to ancestral forms on the line of development terminating in *D. denticulatum*, still it is very unlikely that they are in all respects identical with these ancestral forms. The best way to represent such a case diagrammatically would be to place *A. rubra* and *D. mülleri* on the ends of short side branches springing from the main stem at the points which the ancestral forms they seem to resemble probably occupied. In that way the line of evolution of *D. denticulatum* would be shown as passing not *through*, but *close to*, *A. rubra* and *D. mülleri*.

Uljanin represents the Appendiculariidæ giving rise to the Ascidiæ Simplices, from which three lines then diverge, one leading to *Salpa*, the second to the Doliolidæ through *Anchinia*, and the third to the Ascidiæ Compositæ. From this last group (presumably only the typical Compound Ascidians) three lines start upwards, leading,—the first to *Pyrosoma* through *Distaplia* (?), the second to *Botryllus*, and the third to the "Social" Ascidians through *Pseudodidemnum* and *Tridideminum*.

The starting-point in this scheme of evolution is undoubtedly correct. The various existing groups of Tunicata are all descended from common ancestral forms closely resembling the Appendiculariidæ. But the origin of the Salpidæ and the Doliolidæ from groups of the Simple Ascidians is very questionable. The passage from *Appendicularia mossi*[1] through *Anchinia rubra* to *Doliolum*, and through the ancestral Doliolidæ to *Salpa*, seems so simple and natural that it makes it very unlikely that the Thaliacea were ever fixed Simple Ascidians which have undergone great modification and have become free-swimming pelagic organisms again. The argument made use of by Uljanin that the Thaliacea, &c., have not such a typical method of development as the Simple Ascidians, and are therefore a younger group, is not necessarily of great value, since the process of development may have undergone modification.

Then, again, it seems more probable that the Simple and the Compound Ascidians were derived from a common ancestor resembling the simpler forms of the two groups (*e.g. Ciona* and *Diazona*) than that the Compound were derived from the Simple. Many of the Simple Ascidians show far more differentiation and far more specialisation of certain important organs (*e.g.* the branchial sac in the Molgulidæ) than is found in any of the Compound Ascidians.

I must protest against Uljanin's statement that the "Social" Ascidians are a group derived from the Compound forms and having no close connection with the Simple Ascidians. This view is opposed to all we know as to the very close relationship[2] between the Clavelinidæ and the Ascidiidæ. There can, I think, be no doubt, after the examination of such a series of forms as *Diazona*, *Clavelina*, *Ecteinascidia*, and *Ciona*, that the "Social" Ascidians (Clavelinidæ) are intermediate between the least modified forms of the Simple Ascidians (*e.g. Ciona*) and the least modified forms of the Compound Ascidians (*e.g. Diazona*), and ought therefore to be regarded as being closely allied to the ancestral forms from which both Simple and Compound Ascidians were derived.

I agree with Dr. Uljanin in considering *Pyrosoma* a modified Compound Ascidian, but I differ from him inasmuch as I regard it as being derived from the family Didemnidæ, and not from *Distaplia*. The remarkable new genus *Cœlocormus*, found during the *Challenger* Expedition,[3] is a valuable connecting-link between *Pyrosoma* and the primitive Didemnidæ, which in their turn were derived from the primitive Distomidæ, thus carrying the origin of *Pyrosoma* back to the typical Compound Ascidians.

Distaplia, which figures in Uljanin's scheme as the stepping-stone to *Pyrosoma*, is not really such an extraordinary form as has been supposed. It is an ordinary Compound Ascidian belonging to the family Distomidæ. The Didemnidæ (*e.g. Tridideminum*) and the Diplosomidæ (*e.g. Pseudodidemnum*) are not at all closely related to the "Social" Ascidians. They are highly modified and in some respects degenerate Compound Ascidians which have probably originated from the primitive Distomidæ.

Dr. Uljanin is, I think, right in regarding the Botryllidæ as an abnormal group of Compound Ascidians worthy of being placed in a branch by themselves. They show certain resemblances to some of the Simple Ascidians, and it is just a question whether they should not be regarded as a remarkably modified offshoot from the primitive Cynthiidæ quite distinct from the other Compound Ascidians. I am inclined to regard the Compound Ascidians as polyphyletic. There is some evidence in favour of their having arisen as three distinct groups from the ancestral Social and Simple Ascidians, and in that case one of these groups would be the Botryllidæ. This question will be discussed more in detail in a paper I am now preparing on the Phylogeny of the Tunicata.

On some points, then, I am quite in accord with Dr. Uljanin, while we differ on others. With the modifications suggested above I would accept his views. Probably the most valuable part of his scheme is that dealing with the evolution of the Doliolidæ, and the relations between the different forms of *Doliolum* and *Anchinia*.

W. A. HERDMAN

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for February 1886 contains:—On the development of the mole (*Talpa europæa*); the ovarian ovum and segmentation of the ovum, by Walter Heape, M.A. (plate 11). Of the two membranes the outer (zona radiata) was thick, the inner (vitelline) thin; between them there was a space; radial canals exist in the outer membrane; no micropyle was observed. Two kinds of yolk are noticed—homogeneous vesicular and minute highly refractive bodies. During maturation the vitellus divided into a medullary and cortical portion, and withdrew from the vitelline membrane, excepting where connected by pseudopodia-like processes, and at the spot where the polar bodies are formed. A single spermatozoon appears to effect impregnation. Segmentation occurs while the ovum traverses the Fallopian tube.—On the development of the Cape species of Peripatus, by Adam Sedgwick, M.A., part 2 (plates 12-14). This part is chiefly devoted to a consideration of the segmentation of the ovum and the formation of the layers. The important and in several cases novel facts brought to notice do not readily admit of being abstracted. The embryo at the gastrula stage and in all the earlier stages of development is a syncytium: no part of the nucleus or centre of force of the unsegmented ovum enters the clear endoderm masses. The gastrula gut arises from an enlargement and confluence of the vacuoles in the centre of the mass.—Studies on earthworms, by W. B. Benham, B.Sc. (plates 15, 16, 16 *bis*). In this series of papers the authors describe a number of earthworms from various parts of the world, placed at his disposal by Prof. Lankester; these include new genera and species. In this paper, after an historical *résumé*, a notice of the hitherto known genera and species is given, and *Microchæta rappi*, Bedd., is described and figured.—The official refutation of Dr. Robert Koch's theory of cholera and commas.

The Journal of the Royal Microscopical Society for February 1886 contains:—Fresh-water algæ (including chlorophyllaceous Protophyta) of the English Lake District, with descriptions of twelve new species, by A. W. Bennett, F.L.S. (plates 1 and 2). A record of a six weeks' collecting in the district between Windermere and Langdale, and no doubt only an indication of what a more protracted study would do for the Lake flora.—Explanatory notes on a series of slides presented to the Society, illustrating the action of a diamond in ruling lines upon glass, by Prof. W. A. Rogers.—On the preparation of sections of pumice-stone and other vesicular rocks, by Dr. H. J. Johnston-Lavis.—On the cultivation of Bacteria, by Dr. E. M. Crookshank (plates 3-5).—On the appearance which some micro-organisms present under different conditions—as exemplified in the microbe of chicken-cholera, by G. F. Dowdeswell, M.A.

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[1] I have ventured to call by this name a species described as new, but not named, by Dr. Moss (*Trans. Linn. Soc. Lond.*, vol. xxvii. p. 229, 1871).

[2] See Herdman, "Report upon *Challenger* Tunicata," part i., and Sluiter, "Ueber einige einfachen Ascidien," &c., *Natuurkundig Tijdschrift v. Nederlandsch-Indie*, Band xlv. p. 160, 1885.

[3] See "Report upon *Challenger* Tunicata," part ii.

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